U.S. Department of Transportation
Federal Aviation Administration

Subject:	INFORMATION: Free-play limits and inspection procedures for flutter prevention, § 25.629 and Advisory Circular (AC) 25.629-1A	Date:	September 27, 2000
From:	Manager, Transport Airplane Directorate, Aircraft Certification Service, ANM-100	Reply to Attn. of:	00-115-17
To:	SEE DISTRIBUTION LIST		

The establishment of free-play (or backlash) limits for control surfaces, and the associated periodic inspection procedures for excessive free-play, has been a long standing certification practice for compliance with § 25.629, as discussed in AC 25.629-1A.

Recent service experience with in-flight vibration incidents indicate that there is a greater need to focus on this aspect of compliance with section 25.629. The in-service vibration events that arise from excessive free-play, are self-excited oscillations in which the amplitude is limited due to the non-linearity caused by the backlash in the control system. Although this aeroelastic phenomenon may mimic a forced structural vibration, it has no external exciting force. It is, in fact, a type of flutter, although it is not the classical divergent flutter more commonly associated with the name. Even in its limited amplitude state, the oscillation can cause rapid wear, fatigue, or other damage. The oscillation can evolve into divergent flutter once the free-play increases beyond a certain level that is difficult or impossible to predict by analysis. In order to avoid the serious connotations associated with divergent flutter, the manufacturers prefer to call this limited amplitude phenomena a “vibration” or an “oscillation.” Irrespective of what name is applied, it is still a very serious occurrence that must be prevented and it falls under the purview of § 25.629.

One of the reasons for some of the recent in-service events is related to changing technology. The control of free-play is usually associated with irreversible control surfaces. These are control surfaces that are not balanced to preclude flutter but prevent flutter by having a high degree of rotational stiffness with respect to forces applied to the surface. Formerly such irreversible control surfaces were mainly limited to small tabs, but since the mid-1980’s manufacturers have come to rely on retained stiffness in powered actuators for the main control surfaces and they have dispensed with the mass balance weights on the elevators, rudders, and ailerons. Controlling free-play on these larger control surfaces is even more important since they have a much larger destructive potential if they should vibrate with a significant amplitude or develop divergent flutter. Trimable stabilizers are also large irreversible surfaces that can lead to severe vibration events if adequate free play limits and procedures are not prescribed for the stabilizer actuators and pivot bearings.

The FAA has historically considered the very conservative free-play limits of Military Specification MIL-A-8870 to provide assurance of freedom from vibration and has accepted these limits for certification without further question. However, in many cases, these limits are considered too conservative and too small to be practically controlled in a realistic service environment. In such cases the manufacturers have provided analyses and/or flight tests to confirm the adequacy of the larger amounts of free-play.

Service experience is showing that some of the free-play check procedures that have been established during certification may not be reliable for checking for all the relevant free-play in the system. Free-play in the control surface hinges as well as in the actuator attachments all contribute to the total surface free-play and the check procedure must be able to reliably measure the total free-play. One factor effecting the ability to check for free-play is the large size of the main control surfaces. For small tabs, the inspector could simply move the surface with a hand while using a dial indicator to measure trailing edge motion. With the unbalanced main control surfaces it takes a much greater force to move them and for the surfaces envisioned for larger airplanes it may be impossible to check for free-play without some automatic powered means.

In some cases, free-play in individual parts may exist, but the system rigging can be purposely cross rigged or otherwise set so that the overall free-play is apparently eliminated. Although this practice may be useful for preventing low level vibrations that might contribute to rapid wear, it may also mask increasing wear in the individual parts. If this wear occurs undetected to a significant level, then, after a single failure in the system, a very large amount of free-play could suddenly exist with very severe consequences. This should be taken into account in developing free-play check procedures.

In summary, reliable free-play inspection procedures, suitable inspection intervals, and free-play limits for all the unbalanced control surfaces and trimable stabilizer should be established as part of the compliance determination for § 25.629. The limits, intervals, and associated procedures should be evaluated and approved as part of the certification process and subsequently prescribed as maintenance limitations for the airplane.

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